CLAIMS

I CLAIM:

1. A sample system investigation system comprising:

a) a plurality of electromagnetic radiation sources, each thereof optionally having polarization state setting means functionally associated therewith;

b) a means for accepting at least two electromagnetic beams which approach along different loci, and providing an electromagnetic beam which exits therefrom along a single locus;

c) a stage for supporting a sample system;

d) at least one detector system;

said at least first means for accepting at least two electromagnetic beams which approach along different loci, and providing an electromagnetic beam which exits therefrom along a single locus, being positioned with respect to at least two of said plurality of sources of electromagnetic radiation such that a beam of electromagnetic radiation from either thereof, when it is energized, enters thereinto and emerges therefrom along a locus which is directed toward a sample system placed on said stage for supporting a sample system;

said at least one detector system being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after said beam of electromagnetic

radiation interacts therewith.

2. A sample system investigation system as in Claim 1, in which none of said plurality of electromagnetic radiation sources has polarization state setting means functionally associated therewith.

3. A sample system investigation system as in Claim 1, in which at least one of said plurality of electromagnetic radiation sources has polarization state setting means functionally associated therewith which changes the phase angle between orthogonal components and/or the magnitude of least one orthogonal component of said electromagnetic beam of radiation provided by said source of polychromatic electromagnetic radiation.

4. A sample system investigation system as in Claim 1, in which at least a first and a second of said plurality of electromagnetic radiation sources each have polarization state setting means functionally associated therewith, the polarization state setting means associated with said first electromagnetic radiation source being set to provide a different polarization state on a beam of electromagnetic radiation emerging therefrom than does the polarization state setting means associated with said second electromagnetic radiation source impose on a beam of electromagnetic radiation emerging from said second electromagnetic radiation source.

5. A sample system investigation system as in Claim 1, in which at least one of said plurality of electromagnetic radiation sources provides a beam characterized by a selection from the group consisting of:

being substantially monochromatic electomagnetic radiation;

and

being polychromatic electomagnetic radiation.

6. A sample system investigation system as in Claim 1, in which a focusing lens is present in said beam of electromagnetic radiation which is directed toward a sample system placed on said stage for supporting a sample system.

7. A system as in Claim 1 in which at least one of said plurality of electromagnetic radiation sources is a system for for providing an output beam of polychromatic electromagnetic radiation which has a relatively broad and flattened intensity vs. wavelength characteristic over a wavelength spectrum comprising:

a. at least a first and a second source of electromagnetic radiation comprising a selection from the group consisting of:

being substantially monochromatic; and
beign polychromatic; and

b. at least one electromagnetic beam combining means comprising a plate wherein the transmission characteristics thereof are determined by angle-of-incidence and polarization state of a beam of electromagnetic radiation;

said at least one electromagnetic beam combining means being positioned with respect to said first and second sources of electromagnetic radiation, such that a beam of electromagnetic radiation from said first source of electromagnetic radiation passes through said at least one electromagnetic beam combining means, and such that a beam of electromagnetic radiation from said second source of polychromatic electromagnetic radiation

reflects from said at least one electromagnetic beam combining means and is comingled with said beam of electromagnetic radiation from said first source of electromagnetic radiation which passes through said at least one electromagnetic beam combining means, the resultant beam of electromagnetic radiation being substantially an output beam of polychromatic electromagnetic radiation which has a relatively broad and flattened intensity vs. wavelength over a wavelength spectrum, comprising said comingled composite of a plurality of input beams of electromagnetic radiation which individually do not provide such a relatively broad and flattened intensity vs. wavelength over a wavelength spectrum characteristic.

8. A method of analyzing a sample system comprising the steps of:

A) providing a sample system investigation system comprising:

a) a plurality of electromagnetic radiation sources, each thereof optionally having polarization state setting means functionally associated therewith;

b) a means for accepting at least two electromagnetic beams which approach along different loci, and providing an electromagnetic beam which exits therefrom along a single locus;

c) a stage for supporting a sample system;

d) at least one detector system;

e) computation means;

said at least first means for accepting at least two

electromagnetic beams which approach along different loci, and providing an electromagnetic beam which exits therefrom along a single locus, being positioned with respect to at least two of said plurality of sources of electromagnetic radiation such that a beam of electromagnetic radiation from either thereof, when it is energized, enters thereinto and emerges therefrom along a locus which is directed toward a sample system placed on said stage for supporting a sample system;

said at least one detector system being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after said beam interacts therewith;

B) energizing one of said sources of electromagnetic radiation and accumulating data from said at least one detector system;

C) optionally energizing a second of said sources of electromagnetic radiation and accumulating data from said at least one detector system;

D) optionally energizing a third of said sources of electromagnetic radiation and accumulating data from said at least one detector system;

E) optionally energizing a fourth of said sources of electromagnetic radiation and accumulating data from said at least one detector system;

F) applying said computation means to analyze said sample system utilizing said accumulated data.

9. A method of analyzing a sample system as in Claim 8, in which the step of providing a sample system investigation system involves providing a sample system investigation system

characterized by a selection from the group consisting of:

none of said plurality of electromagnetic radiation sources has polarization state setting means functionally associated therewith;

at least one of said plurality of electromagnetic radiation sources has polarization state setting means functionally associated therewith;

at least one of said plurality of electromagnetic radiation sources provides a beam of substantially monochromatic electomagnetic radiation;

at least one of said plurality of electromagnetic radiation sources provides a beam of polychromatic electomagnetic radiation;

at least a first and a second of said plurality of electromagnetic radiation sources each have polarization state setting means functionally associated therewith, the polarization state setting means associated with said first electromagnetic radiation source being set to provide a different polarization state on a beam of electromagnetic radiation emerging therefrom than does the polarization state setting means associated with said second electromagnetic radiation source impose on a beam of electromagnetic radiation emerging from said second electromagnetic radiation source.

10. A method of analyzing a sample system as in Claim 8, in which at least a first and a second of said plurality of electromagnetic radiation sources each have polarization state setting means functionally associated therewith, the

polarization state setting means associated with said first electromagnetic radiation source being set to provide a different polarization state on a beam of electromagnetic radiation emerging therefrom than does the polarization state setting means associated with said second electromagnetic radiation source impose on a beam of electromagnetic radiation emerging from said second electromagnetic radiation source, and in which said at least first and second of said plurality of electromagnetic radiation sources are sequentially energized in steps B) and (C).

11. A sample system investigation system comprising:

a) at least a first and a second source of electromagnetic radiation, each thereof having polarization state setting means functionally associated therewith;

b) at least a first electromagnetic beam combining means;

c) a stage for supporting a sample system;

d) analyzer means;

e) at least one detector system;

said at least a first electromagnetic beam combining means being positioned with respect to first and second sources of electromagnetic radiation such that a polarized beam of electromagnetic radiation from said first source of electromagnetic radiation, when it is energized, passes through said at least a first electromagnetic beam combining means, and such that a polarized beam of electromagnetic radiation from said second source of electromagnetic radiation, when it is energized, reflects from said at least a first electromagnetic beam combining means;

a beam of electromagnetic radiation exiting said first electromagnetic beam combining means along a locus which is directed toward a sample system placed on said stage for supporting a sample system;

said at least one detector system comprising said analyzer means and being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after interaction therewith.

12. A sample system investigation system as in Claim 11, which further comprsises:

f) a third and a fourth source of electromagnetic radiation, each thereof having polarization state setting means functionally associated therewith;

g) a second electromagnetic beam combining means; and

h) a third electromagnetic beam combining means;

said third electromagnetic beam combining means being positioned such that said beam of electromagnetic beam exiting said first electromagnetic beam combining means along a locus which is directed toward a sample system placed on said stage for supporting a sample system, passes therethrough before proceeding toward said sample system;

said second electromagnetic beam combining means being positioned with respect to said third and fourth sources of electromagnetic radiation such that a polarized beam of electromagnetic radiation from said third source of electromagnetic radiation, when it is energized, passes through said second electromagnetic beam

combining means, and such that a polarized beam of electromagnetic radiation from said fourth source of electromagnetic radiation, when it is energized, reflects from said second electromagnetic beam combining means;

a beam of electromagnetic radiation exiting said second electromagnetic beam combining means along a locus which is directed toward said third electromagnetic beam combining means, reflects off thereof and proceed toward said sample system;

said at least one detector system comprising said analyzer means and being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after interaction therewith.

13. A sample system investigation system as in Claim 11 in which the polarization state setting means functionally associated with said first and second sources of electromagnetic radiation are at azimuthal orientations offset from one another.

14. A sample system investigation system as in Claim 12 in which the polarization state setting means functionally associated with said first and second and third and fourth sources of electromagnetic radiation are at azimuthal orientations offset from one another.

15. A sample system investigation system as in Claim 11 in which the polarization state setting means functionally associated with said first and second sources of electromagnetic radiation are at azimuthal orientations offset 45 degrees from one another.

16. A sample system investigation system as in Claim 12 in which the polarizer means functionally associated with said first and second and third and fourth sources of electromagnetic radiation

are at azimuthal orientations offset 45 degrees from one another.

17. A sample system investigation system as in Claim 1 in which said first and second sources of electromagnetic radiation comprise light emitting diodes.

18. A sample system investigation system as in Claim 11 in which said first, second, third and fourth sources of electromagnetic radiation comprise light emitting diodes.

19. A sample system investigation system as in Claim 11 in which said at least one detector system comprises a polarization state dependent beam splitter and two detectors, which each receive a beam emerging from said beam splitter.

20. A sample system investigation system as in Claim 12 in which said at least one detector system comprises a polarization state dependent beam splitter and two detectors, which each receive a beam emerging from said beam splitter.

21. A method of analyzing a sample system comprising the steps of:

A) providing a sample system investigation system comprising:

a) at least a first and a second source of electromagnetic radiation, each thereof having polarization state setting means functionally associated therewith, said polarization state setting means functionally associated with said first and said second sources of electromagnetic radiation being at azimuthal orientations offset from one another;

b) first electromagnetic beam combining means;

c) a stage for supporting a sample system;

d) analyzer means;

e) at least one detector system;

f) computational means;

said first electromagnetic beam combining means being positioned with respect to first and second sources of electromagnetic radiation such that a polarized beam of electromagnetic radiation from said first source of electromagnetic radiation, when it is energized, passes through said first electromagnetic beam combining means, and such that a polarized beam of electromagnetic radiation from said second source of electromagnetic radiation, when it is energized, reflects from said at least a first electromagnetic beam combining means;

a beam of electromagnetic radiation exiting said first electromagnetic beam combining means being along a locus which is directed toward a sample system placed on said stage for supporting a sample system such that it interacts with said sample system and proceeds into said analyzer means;

said at least one detector system comprising said analyzer means and being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after interaction therewith;

then in either order practicing the following steps B and C:

B) energizing said first source of electromagnetic radiation and accumulating data from said at least one detector system; and

C) energizing said second source of electromagnetic radiation and accumulating data from said at least one detector system;

and then practicing step D);

D) applying said computation means to analyze said sample system utilizing said accumulated data.

22. A method of analyzing a sample system comprising the steps of:

A) providing a sample system investigation system comprising:

a) first, second, third and fourth sources of electromagnetic radiation, each thereof having polarization state setting means functionally associated therewith, said polarization state setting means functionally associated with said first, second, third and fourth sources of electromagnetic radiation being at orientations offset from one another;

b) first, second and third electromagnetic beam combining means;

c) a stage for supporting a sample system;

d) analyzer means;

e) at least one detector system;

f) a computation means;

said first electromagnetic beam combining means being positioned with respect to first and second sources of electromagnetic radiation such that a polarized beam of electromagnetic radiation

from said first source of electromagnetic radiation, when it is energized, passes through said at least said first electromagnetic beam combining means, and such that a polarized beam of electromagnetic radiation from said second source of electromagnetic radiation, when it is energized, reflects from said at least a first electromagnetic beam combining means;

said second electromagnetic beam combining means being positioned with respect to said third and fourth sources of electromagnetic radiation such that a polarized beam of electromagnetic radiation from said third source of electromagnetic radiation, when it is energized, passes through said second electromagnetic beam combining means, and such that a polarized beam of electromagnetic radiation from said fourth source of electromagnetic radiation, when it is energized, reflects from said second electromagnetic beam combining means;

said third electromagnetic beam combining means being positioned such that said beam of electromagnetic beam exiting said first electromagnetic beam combining means passes therethrough and proceeds toward said sample system and such that such that said beam of electromagnetic beam exiting said second electromagnetic beam combining means reflects therefrom and proceeds toward said sample system;

said at least one detector system comprising said analyzer means and being positioned to intercept a beam which emerges from the sample system on said stage for supporting a sample system after interaction therewith;

then in any functional order practicing at least two steps selected from the group consisting of:

B) energizing said first source of electromagnetic radiation

and accumulating data from said at least one detector system;

C) energizing said second source of electromagnetic radiation and accumulating data from said at least one detector system;

D) energizing said third source of electromagnetic radiation and accumulating data from said at least one detector system;

E) energizing said fourth source of electromagnetic radiation and accumulating data from said at least one detector system; and

F) applying said computation means to analyze said sample system utilizing said accumulated data.

23. A sample system investigation system as in claim 1, which further comprises at least one compensator prior to and/or after the stage for supporting a sample system.

24. A sample system investigation system as in claim 11 which further comprises at least one compensator prior to and/or after the stage for supporting a sample system.

23. A sample system investigation system as in claim 1, in which the detector system comprises a beam splitting analyzer means and two detector elements.

24. A sample system investigation system as in claim 11 in which the detector system comprises a beam splitting analyzer means and two detector elements.

25. A sample system investigation system as in claim 1, in which the at least a first and a second source of electromagnetic radiation are light emitting diodes and the path length from each of said at least first and second light emitting diodes to said

sample are substantially the same.

26 A sample system investigation system as in claim 11 in which the at least a first and a second source of electromagnetic radiation are light emitting diodes and the path length from each of said at least first and second light emitting diodes to said sample are substantially the same.

27. A method of analyzing a sample system as in Claim 21 in which the step of providing at least a first and a second source of electromagnetic radiation involves providing light emitting diodes which are positioned such that the path length from each of said at least first and second light emitting diodes to said sample are substantially the same.

28. A method of analyzing a sample system as in Claim 22 in which the step of providing at least a first and a second source of electromagnetic radiation involves providing light emitting diodes.

29. A spectroscopic ellipsometer system comprising:

source means of polychromatic electromagnetic radiation;
a stage for supporting a sample system;
a multi-element spectroscopic detector system;

said spectroscopic ellipsometer system further comprising:

a polarizer, which remains fixed in position during data acquisition, after the source means of polychromatic electromagnetic radiation and before the stage for supporting a sample system;

an analyzer, which remains fixed in position during data

acquisition, after said stage for supporting a sample system and before said multi-element spectroscopic detector system;

and at least one means for discretely, sequentially, modifying a polarization state of a beam of electromagnetic radiation provided by said source means of polychromatic electromagnetic radiation through a plurality of polarization states, said means for discretely, sequentially, modifying a polarization state of a beam of electromagnetic radiation provided by said source means of polychromatic electromagnetic radiation through a plurality of polarization states being present at at least one location selected from the group consisting of:

between said polarizer and said stage for supporting a sample system; and

between said stage for supporting a sample system and said analyzer;

and positioned so that said beam of electromagnetic radiation transmits therethrough in use;

said ellipsometer system being configured such that a polychromatic beam of electromagnetic radiation provided by said source means of polychromatic electromagnetic radiation is directed to interact with a sample system present on said stage for supporting a sample system;

said ellipsometer system being distinguished in taht said source means of polychromatic electromagnetic radiation comprises:

a. at least a first (SS1) and a second (SS2) source of polychromatic electromagnetic radiation beams, (IB1) and

(IB2) respectively; and

b. at least one electromagnetic beam combining (BCM) means comprising an uncoated plate with transmission characteristics that are determined by angle-of-incidence and polarization state of a beam of electromagnetic radiation.

such that in use one of said (IB1) and (IB2) beams passes through said beam combining (BCM) means and the other thereof reflects from said beam combining means, such that a beam containing wavlengths from both (SS1) and (SS2) sources emerges from said beam combining (BCM) means is the beam directed to interact with said sample system present on said stage for supporting a sample system;

and

B.

an electromagnetic beam chromatic shifting and directing means (ZCM) for use in reflectively directing a spectroscopic beam of electromagnetic radiation while de-emphasizing intensity in visual wavelengths and while simultaneously increasing both IR and UV wavelength intensities, said electromagnetic beam chromatic shifting and directing means comprising a silicon substrate with between 500 and 1500 Angstroms of silicon dioxide substantially uniformly present on a reflective surface thereof.

30. A system as in Claim 1 in which at least one of said plurality of electromagnetic radiation sources comprises a system for for providing an output beam of polychromatic electromagnetic radiation which has a relatively broad and flattened intensity vs. wavelength characteristic over a wavelength spectrum

comprises a Silicon Substrate upon a surface of which is present between about 500 and 1500 Angstroms of SiO2, the effect of reflecting a beam of polychromatic radiation therefrom is to de-emphasize intesnity in the Visual and emphasize intensity in the IR and UV wavelength ranges.